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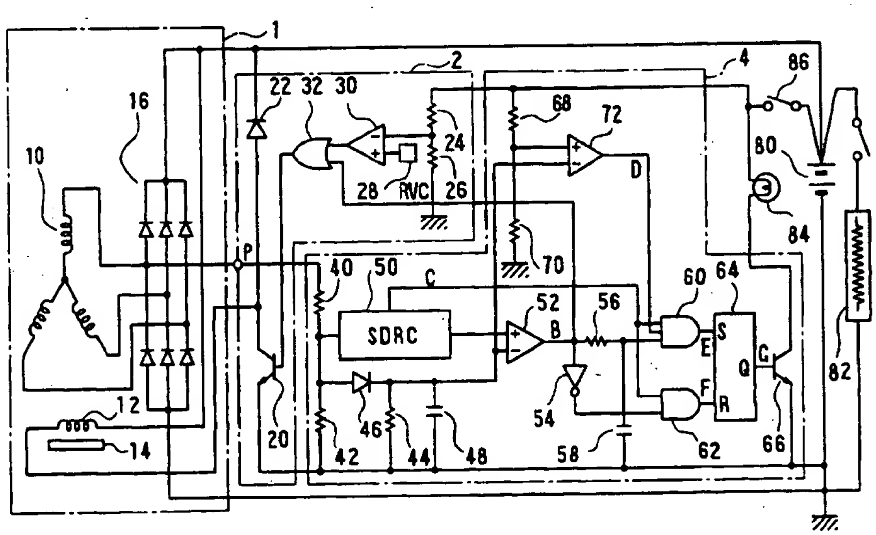
(54) Generation-stop detection system of alternator

(57) A generation-stop detection system of an alternator (1) is composed of a unit (48, 50, 52) for providing a generation-stop condition signal when output voltage of the alternator (1) is lower than a reference voltage, a rotation speed detection unit (40, 42), a reference-voltage changing unit (502, 506) which changes the reference voltage proportionally to the rotation speed of said alternator (1), and a warning signal unit (64, 84) which provides a warning signal if the generation-stop condition signal is provided at a rotation speed lower than a predetermined speed. The warning signal is maintained even if the rotation speed of said alternator (1) becomes higher than said predetermined speed. The warning signal is interrupted when the output voltage of said alternator (1) is higher than the voltage of the battery (80).

FIG. 1



EP 0 865 143 A2

Description

CROSS REFERENCE TO RELATED APPLICATION

The present application is based on and claims priority from Japanese Patent Applications Hei 9-60710 filed on March 14, 1997 and Hei 9-60711 filed on March 14, 1997, the contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a system for detecting generation-stop condition of the alternator.

2. Description of the Related Art

Generally, a voltage regulation system of an alternator for a vehicle has various warning functions. For example, if the alternator stops generation for some reason while the alternator is rotated by an engine, a battery charge lamp is turned on to warn the driver of the generation stop as an abnormal condition.

A conventional device for watching the generation-stop is shown in JP-A-57-142144 entitled "GENERATION CONTROL DEVICE FOR VEHICLE". In the generation control device, the output voltage, which is obtained by rectifying and smoothing phase voltage generated in the stator coil, is compared with a reference voltage. If the output voltage is lower than the reference voltage, the charge lamp is turned on. If generation stop due to breaking down of the field coil or the like happens, the charge lamp is turned on so that the driver can know the generation stop condition.

However, if the rotor of the alternator is provided with permanent magnets disposed between the claw poles as shown in JP-A-5-207716 and JP-A-7-123664, magnetic flux is supplied from the permanent magnets even when the field current is not supplied to the field coil. Accordingly, when the rotation speed of the alternator increases, the output voltage becomes higher than the reference voltage and the generation stop condition can not be detected. If the reference voltage is raised higher than the voltage generated without the field current supplied to the field coil to prevent the above problem, it would take a long time for the charge lamp to turn off after the engine starts and the alternator generates output voltage higher than the reference voltage. This may mislead the driver to think that the alternator stops generation.

SUMMARY OF THE INVENTION

The present invention is made in view of the above problems. Therefore, an object of the present invention is to provide an improved generation-stop detecting system.

According to the present invention, if it is detected that the alternator stops generation when the rotation speed is in a speed lower than a predetermined speed, a warning signal is provided and maintained thereafter even if the alternator rotates at a speed higher than the predetermined speed thereafter.

According to a main feature of the present invention, a reference voltage is provided to detect the generation stop condition and is changed according to the rotation speed as far as the rotation speed is lower than a maximum constant voltage.

Preferably, the reference voltage is set to be proportional to the output voltage generated by the remanent magnetism or the permanent magnets. In particular, because the reference voltage is set to a low voltage when the rotation speed is low, it does not take a long time for the charge lamp to turn off after the key is turned and engine rotates as long as the alternator operates normally.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features and characteristics of the present invention as well as the functions of related parts of the present invention will become clear from a study of the following detailed description, the appended claims and the drawings. In the drawings:

Fig. 1 is a circuit diagram showing the general structure of a generation-stop detecting system according to a preferred embodiment of the present invention;

Fig. 2 is a circuit diagram of a rotation speed detection/reference-voltage changing (SDRC) unit used in the generation-stop detection system shown in Fig. 1;

Figs. 3A-3G are graphs respectively showing relationship between the rotation speed of the alternator and signals applied to or from various portions of a warning unit used in the generation-stop detection system shown in Fig. 1;

Fig. 4 is a circuit diagram of a variation of the rotation speed detection/reference-voltage changing (SDRC) unit shown in Fig.2;

Fig. 5 is a graph showing relationship between the rotation speed of the alternator and reference voltage provided by the rotation speed detection/reference-voltage changing (SDRC) unit shown in Fig. 4;

Fig. 6 is a fragmental perspective view illustrating a rotor of an alternator having permanent magnets therein;

Fig.7 is a circuit diagram of a variation of the warning unit shown in Fig. 1; and

Fig. 8 is a circuit diagram of another variation of the warning unit shown in Fig. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A generation-stop detection system according to a preferred embodiment is described with reference to Fig. 1-Figs. 3A-3G and Fig. 6.

The generation-stop detection system of an alternator 1 is composed of a generation control unit 2, a warning unit 4 and a charge lamp 84.

The alternator 1 is driven by an engine (not shown) and generates output power to be supplied to a battery 80 and an electric load 82. The output voltage is regulated by the generation control unit 2. The alternator 1 is composed of a three-phase stator coil 10, a Lundell type rotor 90 having a field coil 12 and a three-phase full-wave rectifying circuit 16 for rectifying the three-phase alternating current supplied from the output terminals of the stator coil 10. The rotor 90 has a plurality of claw poles 92 and 94 enclosing the field coil 12, and a plurality of permanent magnets 14 disposed between adjacent two of the claw poles 92 and 94 as shown in Fig.6.

The generation control unit 2 is composed of a switching transistor 20, a flywheel diode 22 connected in parallel with the field coil 12, a comparator 30, an OR circuit 32 connected between the comparator 30 and the switching transistor 20, a voltage dividing circuit composed of series connected resistors 24 and 26 and a reference voltage generating unit 28 connected to the plus input-terminal of the comparator 30. The terminal voltage of the battery 80 (or the output voltage of the alternator 1) is divided by the voltage dividing circuit (composed of the resistor 24 and 26) and applied to the minus input-terminal of the comparator 30. If the divided voltage is higher than a reference voltage provided by the reference voltage generating unit 28, the comparator 30 provides a low level signal. If the divided voltage is lower than the reference voltage, the comparator 30 provides a high level signal. If the comparator 30 provides high level signal, the switching transistor 20 is turned on to supply the field current, so that the alternator 1 generates the output power and increases the output voltage. On the other hand, if the comparator 30 provides low level signal, the switching transistor 20 is turned off to cut supply of the field current, so that the output voltage of the alternator lowers. Thus, the output voltage of the alternator 1 is regulated to be constant.

The warning unit 4 is composed of a voltage dividing circuit having series connected resisters 40 and 42, a rotation speed detection/reference-voltage changing unit (hereinafter referred to as SDRC unit) 50, a diode 46, a parallel circuit of resistor 44 and a capacitor 48, a comparator 52, a holding circuit composed of an inverter circuit 54, a delay circuit composed of the resistor 56 and the capacitor 58, AND circuits 60 and 62 and an S-R flip-flop circuit (hereinafter referred to as the SR-FF) 64, a transistor 66, a voltage dividing circuit having series connected resistors 68 and 70, and a comparator 72.

The SDRC unit 50 detects the rotation speed of the alternator 1 and sets and changes a reference voltage for deciding whether the alternator 1 generates power normally or not. The comparator 52 compares the reference voltage set by the SDRC unit 50 with a voltage divided from the output voltage of the alternator 1. The SR-FF 64 holds the comparison result of the comparator 52, and the transistor 66 turns on or off the charge lamp 84 in response to the output signal of the SR-FF 64. The warning unit 4 warns a driver if the alternator stops generation while the alternator 1 is rotated by the engine (herein after referred to as the generation stop condition) by turning on the charge lamp 84.

One phase voltage of the stator coil 10 is applied to a terminal P to be divided by the voltage dividing circuit composed of the resistors 40 and 42 and is applied to the anode of the diode 46. The cathode of the diode 46 is connected to one end of the parallel circuit of resistor 44 and the capacitor 48, whose the other end is grounded. If the potential of the anode of the diode 46 (the divided voltage) is higher than the potential of the junction of the capacitor 48 by the voltage drop of the diode 46, current flows from the diode 46 to the capacitor 48 to charge the capacitor 48 until the potential of the capacitor becomes a voltage that is the forward voltage drop of the diode 46 lower than the peak of the voltage (divided from the phase voltage of the alternator 1) applied to the anode of the diode 46. If the potential of the anode of the diode 46 is lower than the potential of the capacitor 48, current does not flow through the diode 46, and the potential of the capacitor 48 remains to be proportional to the peak of the phase voltage.

The SDRC unit 50 is composed of a comparator 500, a counter 502, a timer 504, a digital-analog converter (D-A converter) 506 and an inverter 508, as shown in Fig. 2. The phase voltage of the stator coil 10 is applied to the plus-input terminal of the comparator 500 through the resistors 40 and 42. The input voltage is compared with a predetermined voltage Vb applied to the minus input-terminal thereof to provide a pulse signal synchronized with the rotation speed of the alternator 1. The voltage Vb applied to the minus input terminal is nearly zero volt, and the comparator 500 provides the pulse signal which is in synchronism with the rotation cycle of the alternator 1.

The counter 502 counts the number of pulses provided by the comparator 500 in a unit time (e.g. 100 msec.) which is set by the timer 504. The counter 502 holds the number counted last time while it is counting the number of pulses to renew the counted last time after the unit time. The counter 502 provides upper (n-m) bits out of n-bits-counted-number (i.e. an upper 5-bits-number is provided instead of an entire 7-bits-number). Accordingly, the counter provides "0" initially until the rotation speed of the alternator 1 exceeds a lower limit speed corresponding to the lower two-bits number. The counted number increases in proportion to the rotation speed thereafter. If the rotation speed of the

alternator 1 increases to a higher limit speed that each bit of the counted number becomes "1", such number is maintained thereafter.

The D-A converter 506 provides an analog signal corresponding to the counted number (digital data) of the counter 502. The D-A converter 506 provides an offset voltage when the rotation speed is lower than the lower limit speed and the counted number of the counter 502 is "0". On the other hand, the D-A converter provides voltage which is proportional to the counted number of the counter 502 when the rotation speed of the alternator 1 exceeds the lower limit speed and the counted number thereof increases. When the rotation speed of the alternator further reaches the upper limit speed and the counted number of the counter is held constant with an upper limit number, the D-A converter 506 provides a constant voltage which corresponds to the upper limit number. Thus, the output voltage of the D-A converter is used to the reference voltage for deciding whether the alternator 1 is in the generation stop condition or not.

The inverter 508 is connected to the output terminal for the uppermost bit of the counter 502. If the rotation speed of the alternator 1 is lower than a certain speed Na and the signal provided by the terminal for the uppermost bit is "0", the inverter 508 provides "1" or the high level signal. On the other hand, if the rotation speed of the alternator 1 is higher than the speed Na and the signal provided by the terminal for the uppermost bit becomes "1", so that the inverter 508 provides "0" or the low level signal.

The comparator 52 compares the potential of the capacitor 48, which corresponds to the output voltage of the alternator, with the reference voltage provided by the D-A converter 506 of the SDRC unit 50. If the potential of the capacitor 48 is higher than the reference voltage, the comparator 52 provides a low level signal. The low level signal represents the normal operation of the alternator. The output signal of the comparator 52 is applied to the R-terminal of the SR-FF 64 through the inverter circuit 54 and the AND circuit 62 and to the S-terminal of the SR-FF 64 through the delay circuit composed of the resistor 56 and the capacitor 58 and the AND circuit 60. If all the signals applied to other input terminals of the AND circuit 60 and 62 are high level signals and the comparator 52 provides the low level signal, the inverter 54 provides the high level signal, thereby causing the SR-FF 64 to provide the high level signal at the R-terminal thereof through the AND circuit 62. Thus, the transistor 66 remains turned off so that the charge lamp 84 remains turned off.

The comparator 72 compares the potential of the capacitor 48 with a voltage divided from the battery voltage by the voltage dividing circuit composed of the resistors 68 and 70. The dividing ratio provided by the resistors 40 and 42 and the dividing ratio provided by the resistors 68 and 70 are arranged so that the comparator 72 can provide the low level signal when the output signal of the alternator 1 becomes higher than the battery voltage. If the potential of the capacitor 48 is higher than the voltage divided by the resistors 68 and 70, in other words, if the output voltage of the alternator is higher than the battery voltage, the comparator 72 provides a low level signal, which is applied to an input terminal of the AND circuit 60.

When the alternator operates normally and the comparator 72 provides the low level signal, it is not necessary to detect the generation stop condition. Accordingly, the high level signal is not applied to the S-terminal of the SR-FF 64 even if the comparator 52 provides the high level signal.

Thus, the output signal for maintaining the last condition (hereinafter referred to as the maintenance signal) is provided by the inverter 508 of the SDRC unit 50 and applied to each of the AND circuits 60 and 62. When the rotation speed of the alternator 1 becomes higher than the speed Na, the terminal of the uppermost bit of the counter 502 provides the high level signal so that the output signal of the inverter 508 of the SDRC unit 50 changes from the high level signal to the low level signal that is the maintenance signal. Consequently, the low level signals are provided by the AND circuits 60 and 62 and are applied to the S-terminal and the R-terminal of the SR-FF 64, thereby maintaining or locking the output signal thereof.

Figs. 3A-3G are graphs showing relationship between the rotation speed of the alternator 1 and the voltage level of input and output signals of various portions of the warning unit 4. In each of Figs. 3A-3G, a dotted line corresponds to the normal operation of the alternator 1 and a solid line corresponds to the generation stop condition, such as when the field coil 12 breaks down and the alternator 1 stops generation. Each of Figs. 3B-G shows the relationship between the voltage level (vertical axis) of one of portions shown in Fig. 1 denoted by corresponding one of reference characters B-G and the rotation speed of the alternator 1 (horizontal axis).

In Fig. 3A, a one-dot-chain line a shows the characteristic curve of the reference voltage provided by the D-A converter 506 of the SDRC unit 50. If the rotor of the alternator 1 has permanent magnets 14 therein, the output voltage of the alternator 1 increases as the rotation speed thereof becomes higher as shown by a solid line **b** in Fig. 3A even if the field current is not supplied to the field coil. When the output voltage exceeds a voltage that is the sum of the battery voltage and the forward voltage drop of the diode of the full-wave rectifying circuit 16, current is supplied to the battery 80 and the electric load 82 through the full-wave rectifying circuit 16. Because the magnetic field caused by the permanent magnets 14 is comparatively smaller than the magnetic field of the field coil supplied with field current, the phase voltage applied to the terminal P is maintained constant by the battery 80 even if the alternator 1 rotates at higher speed.

As shown by the curve a in Fig. 3A, the reference voltage in the middle speed range is set proportional to and a little higher than the maximum voltage (with some variation between individual alternators) that is generated without supplying the field coil, the reference voltage in the low speed range is set to a constant voltage continuous with the reference voltage in the middle speed range, and the reference voltage in the high speed range is the constant voltage which is a little lower than the battery voltage and is continuous with the reference voltage in the middle speed range.

The D-A converter 506 provides the offset voltage which corresponds to the reference voltage in the low speed range. As the rotation speed of the alternator 1 becomes higher, the counted number of the counter 502 increases, so that the output voltage of the D-A converter 506 increases in proportion to the rotation speed. This output voltage corresponds to the reference voltage in the middle speed range. More precisely, the reference voltage corresponding to the counted number of the counter 502 changes stepwise because the counted number of the counter 502 changes stepwise. When the rotation speed of the alternator 1 increases and the counted number of the counter reaches the upper limit number (all bits of the output terminals become "1"), the upper limit number is maintained. Accordingly, the output voltage of the D-A converter 506 becomes constant, and this corresponds to the reference voltage in the high speed range.

When the ignition key is turned, the alternator 1 does not generate power immediately. Consequently, the phase voltage of the stator coil 10 applied to the terminal P is 0 volt, and the comparator 52 of the warning unit 4 provides the high level signal. Accordingly, the terminal Q of the SR-FF 64 provides the high level signal to turn on the transistor 66, thereby turning on the charge lamp 84.

When the ignition key is further turned and the starter (not shown) is started, the rotation speed of the alternator increases as the engine rotates faster. Consequently, the comparator 30 of the generation control unit 4 provides the high level signal so that the switching transistor 20 is turned on to supply the field current to the field coil 12 of the alternator 1 and, therefore, the output voltage of the alternator 1 increases in proportion to the rotation speed thereof.

When the output voltage of the alternator 1 becomes higher than the reference voltage for the low speed range, the comparator 52 provides the low level signal as shown in Fig. 3B. The low level signal is applied to the S-terminal of the SR-FF 64, as shown in Fig. 3E, through the AND circuit 60 and is inverted and applied to the R-terminal of the SR-FF 64, as shown in Fig. 3F, through the AND circuit 62. Thus, the SR-FF 64 is reset so that the low level signal is applied to the base of the transistor 66 from the Q-terminal, as shown in Fig. 3G, to turn off the transistor 66 and the charge lamp 84.

When the output voltage of the alternator 1 becomes higher than the battery voltage, the S-terminal of the SR-FF 64 is shut against the high level signal, thereby preventing the charge lamp 84 from turning on. Thus, the comparator 72 of the warning unit 4 provides the low level signal as shown in Fig. 3D, and the output signal of the AND circuit 60 is locked in the low level signal even if the high level signal is applied to the S-terminal thereafter. Thus, the charge lamp 84 remains turned off.

If the large electric load 82 is disconnected from the battery 80 instantly, the output voltage of the alternator 1 becomes very high even while the alternator 1 is operating normally, and the battery becomes overcharged. Consequently, the field current is cut to stop the generation of the alternator. If the output voltage of the alternator 1 becomes lower than the reference voltage for a corresponding one of the speed ranges, the comparator 52 provides the high level signal. However, the AND circuit 60 maintains the low level signal for a certain period. Because the output terminal of the comparator 52 is connected to one of input terminals of the OR circuit 32 of the generation control unit 2, the high level voltage of the comparator 52 is applied to the base of the switching transistor 20 through the OR circuit 32 to supply the field current to the field coil 12. Therefore, the output voltage of the alternator 1 does not become much lower than the reference voltage. Although the output voltage becomes lower than the reference voltage temporarily, it recovers immediately while the high level output signal of the comparator 52 is delayed and smoothed by the delay circuit. Therefore, the high level signal is not applied to the S-terminal of the SR-FF 64 before the low level signal of the comparator 52 is inverted and applied to the R-terminal of the SR-FF 64. Thus, the transistor 66 is maintained turned off.

If the field coil 12 breaks down when the alternator 1 generates normal output voltage, the warning unit 4 operates as follows. When the rotation speed of the alternator 1 becomes higher than the speed Na, the inverter 508 of the SDRC unit 50 provides the low level maintenance signal. However, this signal is provided only when the rotation speed is in the middle speed range shown in Fig. 3A.

If the generation of the alternator 1 stops while the alternator rotates at a speed lower than the speed Na, the output voltage of the alternator 1 becomes lower than the reference voltage. Consequently, the comparator 52 provides the high level signal, which is applied to the S-terminal of the RS-FF 64 through the AND circuit 60. As a result, the transistor 66 is turned on to energize the charge lamp 84.

When the rotation speed of the alternator 1 is higher than the speed Na, the SDRC unit 50 provides the AND circuits 60 and 62 with the maintenance signal so that output signal of the SR-FF 64 can not be renewed. Thus, if the generation stop condition is detected when the rotation speed of the alternator is lower than the speed Na, the charge lamp 84 is main-

tained turned on, thereafter. If the generation of the alternator 1 stops while the alternator rotates at a speed higher than the speed Na, the output signal of the SR-FF 64 is fixed and the charge lamp 84 is not turned on. However, the generation stop condition is detected once the rotation speed of the alternator 1 becomes low, and the charge lamp 84 is maintained turned on thereafter even if the rotation speed of the alternator 1 becomes high.

Because the reference voltage is set low when the rotation speed of the alternator is low, the charge lamp 84 can be turned off in a short time as long as the alternator 1 is normal.

Fig. 4 shows a variation of the SDRC unit 50. A SDRC unit 50A is composed of the comparator 500, the counter 502, the timer 504, the inverter circuit 508, a NOR circuit 510, a transistor 514 and resistors 512, 516, 518 and 520. The comparator 500, the counter 502, the timer 504 and the inverter 508 are the same in function as those of the SDRC unit 50 shown in Fig. 2. The NOR circuit 510 has three input terminals connected to the output terminals Q5, Q6 and Q7 of upper three bits of seven bits of the counter 502. Accordingly, the NOR circuit 510 provides the high level signal as long as the rotation speed of the alternator 1 is lower than a certain speed, and the low level signal otherwise. The transistor 514 is turned on or off according to the output signal of the NOR circuit 510. If the rotation speed of the alternator 1 is low and the NOR circuit 510 provides the high level signal, the transistor 514 is turned on. Consequently, one end of the resistor 516 connected to the collector thereof is grounded through the collector-emitter path thereof, thereby forming a dividing circuit composed of the resistors 516, 518 and 520. If the rotation speed of the alternator 1 is high and the NOR circuit provides the low level signal, the transistor 514 is turned off. Consequently, the resistor 516 floats, and the voltage dividing circuit is composed of the resistors 518 and 520. Because the voltage dividing ratio of the voltage dividing circuit composed of the three resistors 516, 518 and 520 is smaller than that of the voltage dividing circuit composed of the two resistors 518 and 520, a lower constant reference voltage is provided in the low speed range, and a higher constant reference voltage is provided in the high speed range.

Thus, the reference voltage provided by the SDRC unit 50A is set low when the rotation speed of the alternator is low so that the time period for turning-off of the charge lamp 84 can be reduced. The above reference voltage is set to increase stepwise as the rotation speed of the alternator 1 increases, as shown by a one-dot chain line **d** in Fig. 5, so that the generation stop condition can be detected surely even if the output voltage without field current becomes higher. If the rotation speed of the alternator 1 increases after the generation stop condition is detected, the SDRC unit 50A provides the maintenance signal to maintain the output signal of the SR-FF 64 so that the charge lamp 84 is maintained turned on even if the output voltage of the alternator becomes high temporarily.

It is noted that the SDRC unit 50 can detect the generation stop condition more accurately than the SDRC unit 50A, however the latter is simpler in the structure than the former.

The rotation speed Na is set lower than the rotation speed where the output voltage of the alternator 1 generated when the field current is not supplied to the field coil becomes the same as the reference voltage, in other words, the rotation speed where a one-dot chain line **d** and the solid line **b** (the same as shown in Fig. 3A) cross each other.

Fig. 6 illustrates permanent magnets 14 disposed in the rotor. Each of the magnetized permanent magnets 14 is inserted between the claw poles 92 and 94 of the rotor 90 in the direction that the leakage magnetic flux between the claw poles 92 and 94 is suppressed. The permanent magnets 14 are held in the magnet holders 96 made of non-magnetic metal. Each of the magnet holders 96 can be formed into a box-shape covering the whole outer surfaces of the permanent magnets 14 or molded with resinous material.

In the warning unit 4, it is possible to apply the maintenance signal only to the AND circuit 62 connected to the R-terminal of the RS-FF 64 if the charge lamp 84 does not turn off erroneously. In this case, if the charge lamp 84 is turned on in the low speed range, it is not turned off in the high speed range. The charge lamp 84 can be turned on after the maintenance signal is provided. As far as the output voltage of the alternator 1 is not higher than the battery voltage (while the comparator 72 provides the high level signal), if the output voltage of the alternator 1 becomes lower than the reference voltage provided by the SDRC unit 50 or 50A, the high level signal is applied to the S-terminal of the SR-FF 64 to change the output signal of the SR-FF 64 from the low level to the high level, thereby turning on the charge lamp 84. Thus, the S-terminal of the SR-FF 64 indicates the generation stop condition of the alternator 1 even after the maintenance signal is provided. The present invention can be applied to a rotor without the permanent magnets 14 in the same manner.

Fig. 7 shows a circuit diagram of a warning unit 4A which detects the generation stop condition only through the operation of changing the reference voltage by the SDRC unit 50 or 50A. The warning unit 4A is different from the warning unit 4 in that the SR-FF 64, the AND circuit 62 and the inverter 54 are omitted. Other portions are the same. The omission of the SR-FF 64 can save the maintenance signal provided by the SDRC unit 50 or 50A. Thus, as far as the alternator operates normally, the output voltage thereof is compared with the reference voltage which is proportional to the rotation speed of the alternator to detect the generation stop condition so that the charge lamp 84 can be turned off in the low speed range immediately.

Fig. 8 shows a circuit diagram of a warning unit 4B

for solely maintaining the generation stop condition which is detected in the low speed range, and for providing the reference voltage which is constant over the entire speed range. The warning unit 4B is different from the warning unit 4 in that the SDRC unit 50 is replaced with a circuit 68A for providing the maintenance signal and a reference voltage generating circuit 68B. Other portions are the same as those shown in Fig. 1. The reference voltage generating circuit 68B provides a constant reference voltage in the low speed range as shown by the one-dot chain line a in Fig. 3A. The circuit 68A provides the maintenance signal at a speed lower than the speed where the output voltage of the alternator generated without the field current becomes higher than the constant reference voltage. If the rotation speed becomes higher than this speed, the output signal of the SR-FF 64 is not renewed. Thus, the generation stop condition detected in the low speed range is maintained after the rotation speed increases, so that the charge lamp 84 can be maintained turned on.

In the above embodiment, the generation stop signal can be transmitted to another device such as an engine control unit (ECU) or the like instead of or together with the charge lamp 84 when the generator stop condition is detected.

The SDRC unit 50A shown in Fig. 4 can provide a three-step reference voltage instead of two-step reference voltage.

In the foregoing description of the present invention, the invention has been disclosed with reference to specific embodiments thereof. It will, however, be evident that various modifications and changes may be made to the specific embodiments of the present invention without departing from the broader spirit and scope of the invention as set forth in the appended claims. Accordingly, the description of the present invention in this document is to be regarded in an illustrative, rather than restrictive, sense.

Claims

1. A generation-stop detection system of an alternator (1) having a rotor and a field coil (12) comprising:

   a condition detection unit (48, 50, 52) providing a generation-stop condition signal when output voltage of said alternator (1) shifts from a reference level;
   a speed detection unit (40, 42) detecting rotation speed of said alternator (1), and
   a correction unit (502, 506) for correcting said generation stop-condition signal according to rotation speed of said alternator (1).

2. A generation-stop detection system as claimed in claim 1, wherein said rotor has a permanent magnet (14) disposed in a magnetic field generated by said field coil (12).

3. A generation-stop detection system as claimed in claim 1, wherein

   said condition detection unit (48, 50, 52) provides said generation stop condition signal according to a result of comparison between said output voltage of said alternator (1) and voltage of said reference signal.

4. A generation-stop detection system as claimed in claim 1, wherein said correction unit (502, 506) comprises a reference-voltage changing unit (502, 506) for changing voltage of said reference signal as the rotation speed of said alternator (1) changes.

5. A generation-stop detection system as claimed in claim 4, wherein

   said reference-voltage changing unit (502, 506) increases said voltage of said reference signal as the rotation speed of said alternator (1) becomes higher.

6. A generation-stop detection system as claimed in claim 5, wherein

   the voltage of said reference signal is proportional to and higher than the output voltage of said alternator (1) generated when said field current is not supplied to said field coil (12).

7. A generation stop detection system as claimed in claim 5, wherein the voltage of said reference signal is set lower than the battery voltage.

8. A generation-stop detection system as claimed in claim 5 further comprising a unit (68, 70, 72, 60) for nullifying said generation-stop condition signal when the output voltage of said alternator (1) becomes higher than said battery voltage.

9. A generation-stop detection system as claimed in claim 1, wherein said correction unit (502, 506) comprises a maintenance unit (502, 508, 60, 62) for providing a maintenance signal to maintain said generation-stop condition signal after the rotation speed of said alternator (1) becomes higher than a predetermined speed.

10. A generation-stop detection system as claimed in claim 9, wherein

    said maintenance unit (502, 508, 60, 62) provides a warning signal if said condition detection unit (48, 50, 52) provides said generation-stop condition signal when the rotation speed of said alternator (1) is lower than said predetermined speed.

11. A generation-stop detection system as claimed in claim 9, wherein

said condition detection unit (48, 50, 52) provides said generation stop condition signal according to a result of comparison between said output voltage of said alternator (1) and voltage of said reference signal.

12. A generation-stop detection system as claimed in claim 9, wherein said correction unit (502, 506) comprises a reference-voltage changing unit (502, 506) for changing voltage of said reference signal as the rotation speed of said alternator (1) changes.

13. A generation-stop detection system as claimed in claim 9, wherein

said reference-voltage changing unit (502, 506) increases said voltage of said reference signal as the rotation speed of said alternator (1) becomes higher.

14. A generation-stop detection system as claimed in claim 5, wherein

the voltage of said reference signal is proportional to and higher than the output voltage of said alternator (1) generated when said field current is not supplied to said field coil (12).

FIG. 1

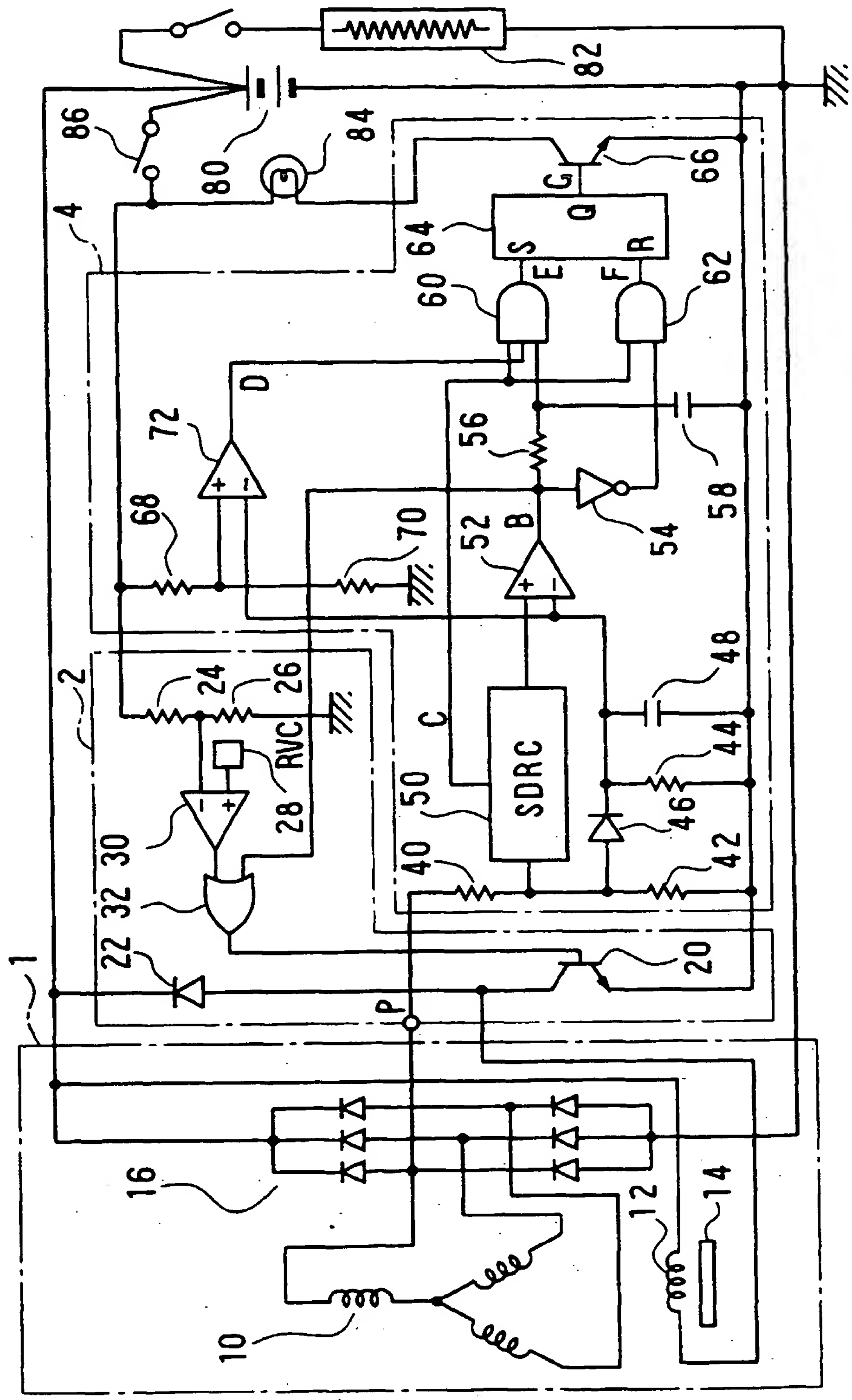


FIG. 2

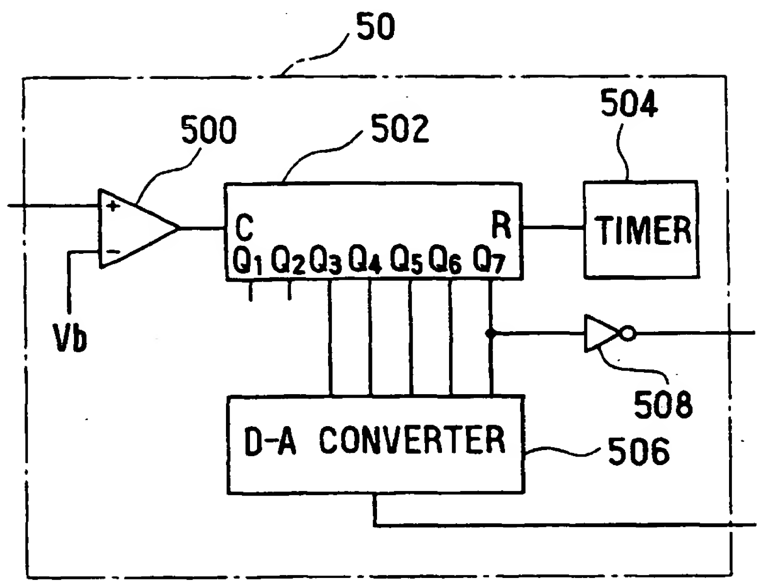

50
500
502
504
C
R
TIMER
Q1 Q2 Q3 Q4 Q5 Q6 Q7
Vb
508
D-A CONVERTER
506

FIG. 4

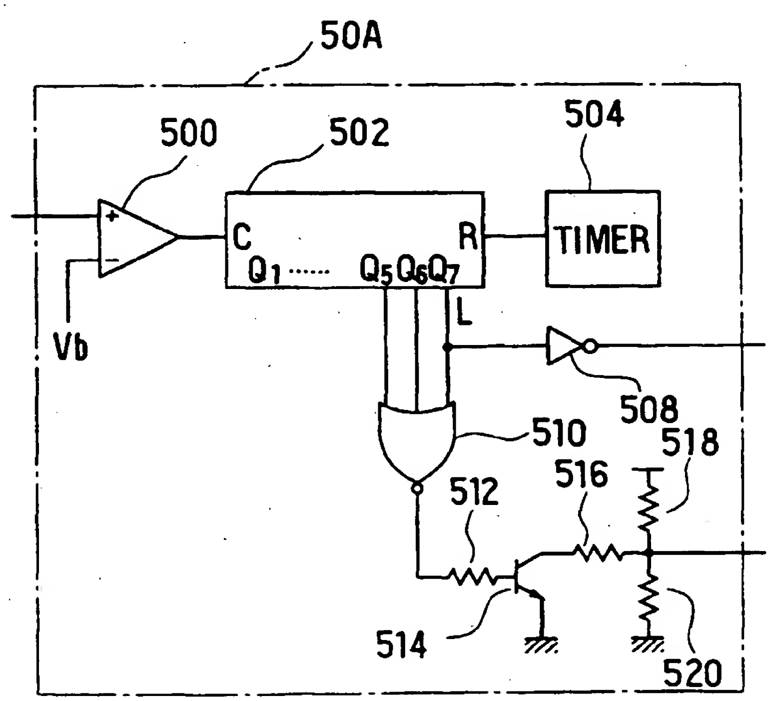

50A
500
502
504
C
R
TIMER
Q1 ...... Q5 Q6 Q7
L
Vb
508
510
518
516
512
514
520

FIG.3A

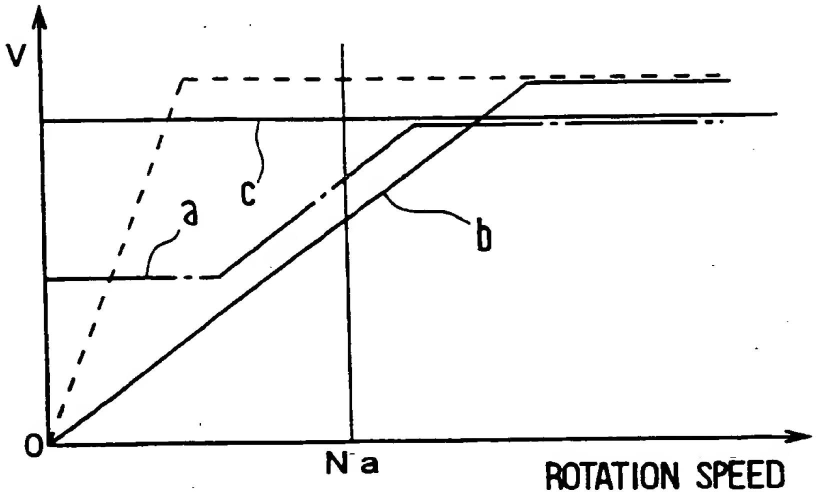


FIG.3B

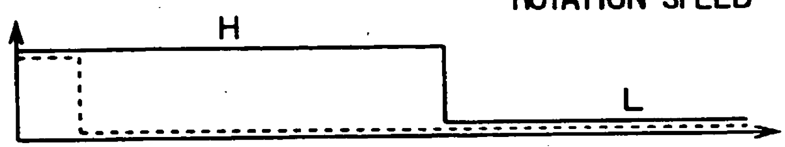


FIG.3C

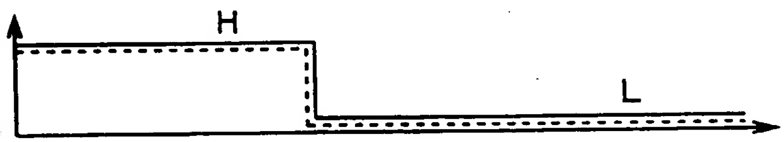


FIG.3D

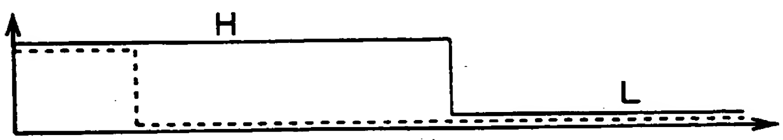


FIG.3E

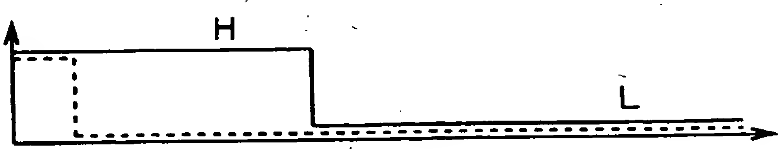


FIG.3F

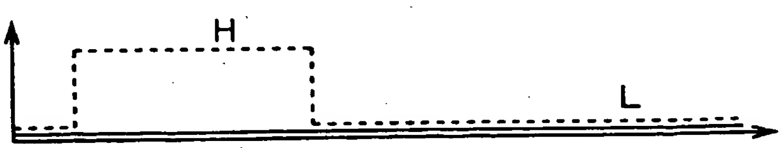


FIG.3G

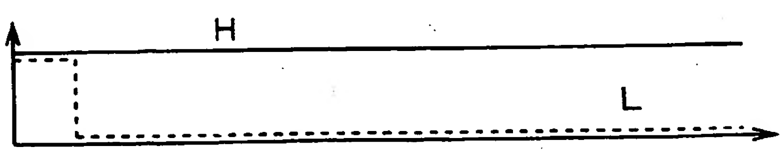


FIG. 5

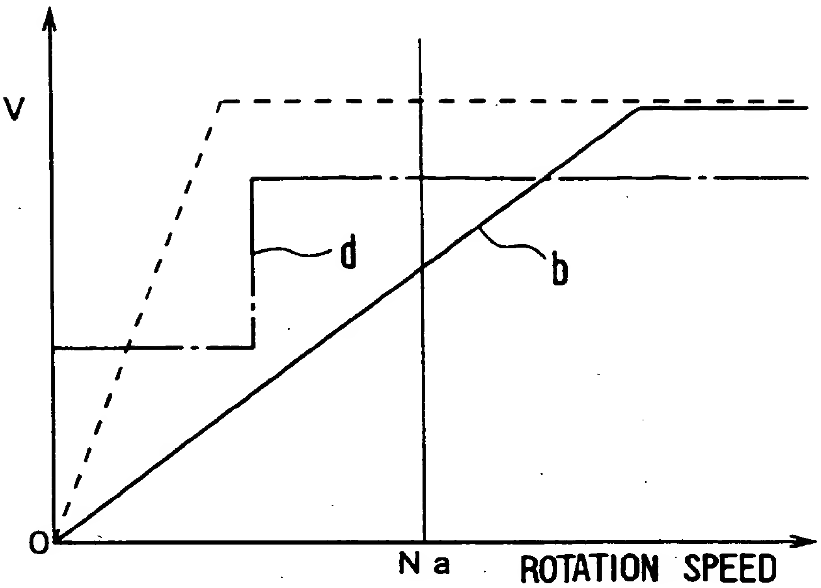


FIG. 6

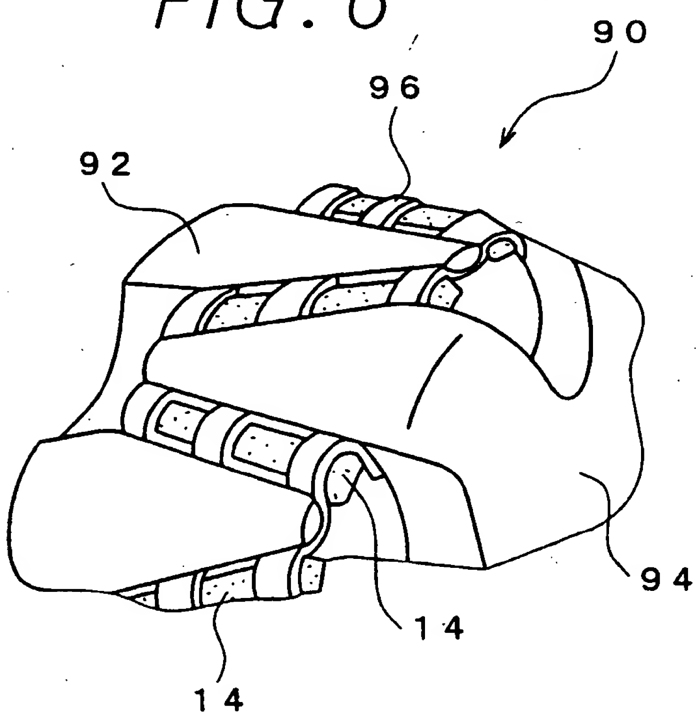


FIG. 7

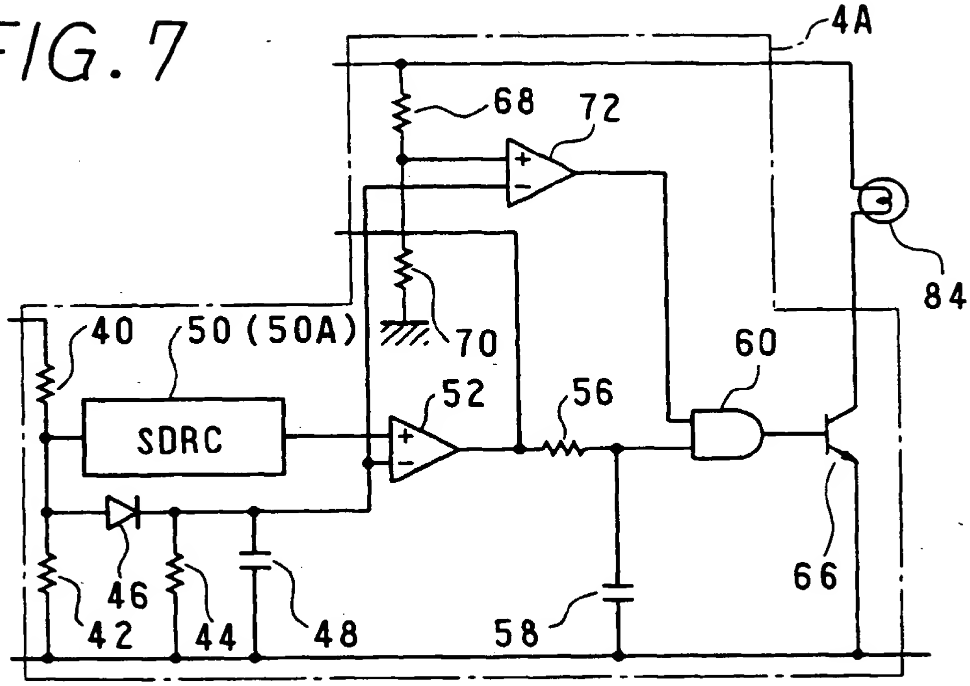
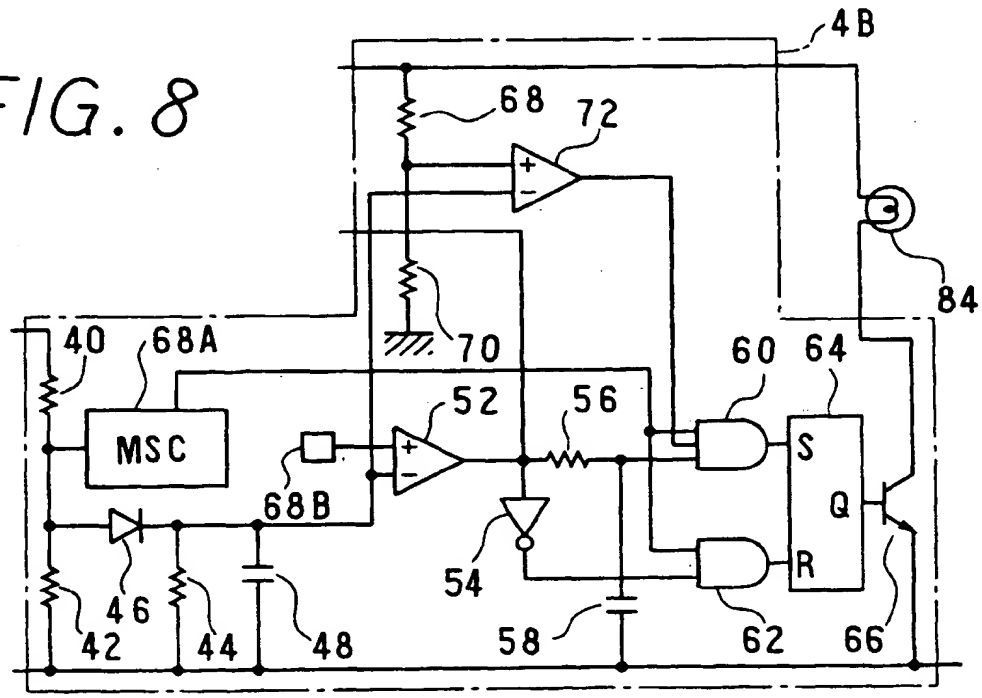

4A
68
72
84
40
50 (50A)
70
60
SDRC
52
56
46
42
44
48
58
66

FIG. 8


4B
68
72
84
40
68A
70
60
64
MSC
52
56
S
Q
68B
54
R
46
42
44
48
58
62
66

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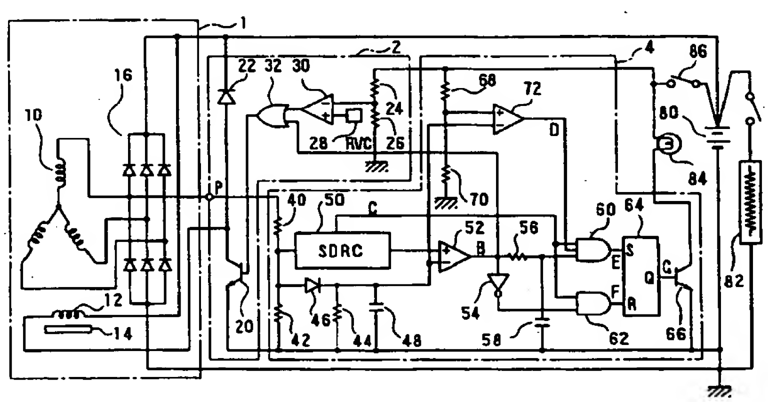
(54) Generation-stop detection system of alternator

(57) A generation-stop detection system of an alternator (1) is composed of a unit (48, 50, 52) for providing a generation-stop condition signal when output voltage of the alternator (1) is lower than a reference voltage, a rotation speed detection unit (40, 42), a reference-voltage changing unit (502, 506) which changes the reference voltage proportionally to the rotation speed of said alternator (1), and a warning signal unit (64, 84) which provides a warning signal if the generation-stop condition signal is provided at a rotation speed lower than a predetermined speed. The warning signal is maintained even if the rotation speed of said alternator (1) becomes higher than said predetermined speed. The warning signal is interrupted when the output voltage of said alternator (1) is higher than the voltage of the battery (80).

FIG. 1



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EUROPEAN SEARCH REPORT

Application Number
EP 98 10 0907

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	EP 0 577 987 A (BOSCH) 12 January 1994 (1994-01-12) * column 2, line 56 - column 6, line 27; figures 1-3 *	1,3,4, 11-13	H02J7/16
A	EP 0 430 208 A (NIPPONDENSO) 5 June 1991 (1991-06-05) * column 3, line 47 - column 19, line 6; figures 1,11 *	1,3,7,11	
A	EP 0 438 884 A (HITACHI) 31 July 1991 (1991-07-31) * column 5, line 57 - column 14, line 45; figures 1,2,19-22 *	1	
A	EP 0 094 685 A (MITSUBISHI) 23 November 1983 (1983-11-23) * page 2, line 22 - page 7, line 38; figure 1 *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A	PATENT ABSTRACTS OF JAPAN vol. 18, no. 687 (E-1651), 26 December 1994 (1994-12-26) & JP 06 276799 A (MITSUBISHI), 30 September 1994 (1994-09-30) * abstract *	1	H02J
A	PATENT ABSTRACTS OF JAPAN vol. 18, no. 551 (E [1619], 20 October 1994 (1994-10-20) & JP 06 197473 A (HITACHI), 15 July 1994 (1994-07-15) * abstract *	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20 August 1999	Calarasanu, P

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20-08-1999

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 577987 A	12-01-1994	DE 4222072 C	03-03-1994
		DE 59307725 D	08-01-1998
		JP 6113600 A	22-04-1994
		US 5352929 A	04-10-1994
EP 430208 A	05-06-1991	AU 637165 B	20-05-1993
		AU 6707390 A	06-06-1991
		DE 69023099 D	23-11-1995
		DE 69023099 T	04-04-1996
		JP 3222636 A	01-10-1991
		KR 141687 B	17-08-1998
		US 5243270 A	07-09-1993
EP 438884 A	31-07-1991	JP 2651030 B	10-09-1997
		JP 3212200 A	17-09-1991
		DE 69025310 D	21-03-1996
		DE 69025310 T	17-10-1996
		US 5231344 A	27-07-1993
EP 94685 A	23-11-1983	JP 58201533 A	24-11-1983
		DE 3378149 A	03-11-1988
		US 4543521 A	24-09-1985
JP 06276799 A	30-09-1994	NONE	
JP 06197473 A	15-07-1994	NONE	

EPO FORM P0459

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